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**Articulated suspension device**

The invention relates to an articulated suspension device  
in particular for support systems of electronic appliances  
5 such as e.g. monitors.

Suspension devices for support systems are currently used  
e.g. in the field of medicine. For every type of  
intervention, treatment, investigation or monitoring  
10 procedure carried out on a patient, the practitioner has at  
his disposal i.a. a wide variety of back-up functions, such  
as measuring, visualizing, lighting etc., that are realized  
by means of electronic appliances and/or systems. As these  
electronic appliances have to be variably positioned and  
15 aligned in dependence upon the position of the patient and  
the practitioner, the appliances are connected to a support  
system, which is fastened by an articulated suspension  
device realized e.g. by means of spring arms to the ceiling  
or to the walls of the room and may be aligned in a  
20 plurality of degrees of translatory and rotatory freedom  
within a limited range of motion.

In order to achieve the smoothest possible rotational and  
tilting movements over a wide rotational and tilting range  
25 in the joints of the suspension device, almost exclusive  
use is made of spherical or part-spherical ball joints.  
From the utility model DE 93 01 268 U1, for example, it is  
known for the articulated joint to comprise an interface  
component carrying a joint ball as well as a connecting  
30 flange containing a joint-ball bearing. The rotational and  
tilting movement of the ball joint is effected by a part-  
spherical sliding movement of the joint ball in the joint-  
ball bearing. Whilst the internal diameter profile of the  
joint-ball bearing corresponds to the part-spherical

surface profile of the joint ball, the external diameter profile corresponding to the internal profile of the connecting flange has a purely cylindrical shape.

5 This geometric simplification, which reduces the outlay for manufacture and assembly of the ball-joint bearing, is however achieved at the cost of considerable mechanical drawbacks. As forces may be transmitted at contact surfaces between various components only in orthogonal  
10 direction to the surface, forces acting in the connecting flange are introduced, because of the cylindrical interfaces between connecting flange and joint-ball bearing, only at right angles to the lateral cylinder surface and/or at right angles to the cylinder bases into  
15 the joint-ball bearing. An introduction of force into the joint-ball bearing that is radially symmetrical and directed towards the centre of the joint ball, such as is effective at the transition from the joint-ball bearing to the joint ball because of the spherical interface, is not  
20 possible. A homogeneous introduction of force into the ball joint bearing and hence an optimum transmission of force to the joint ball that leads to a deflection of the joint ball proportional to the force originally acting upon the connecting flange is therefore not possible. Rather,  
25 the non-radial component of the force acting upon the joint-ball bearing that cannot be transmitted to the joint ball leads to an undesirable reaction of force at the contact surfaces between connecting flange and joint-ball bearing as well as at the fastening elements between both  
30 components. These undesirable reactions of force lead at the said points to component wear owing to compression-, extension- or friction processes.

The underlying object of the present invention is therefore to provide an articulated suspension device which, by virtue of a suitable geometric design of the joint component combination of joint ball - joint-ball bearing - joint connecting flange, guarantees a homogeneous, i.e. radially symmetrical flow of force between these components.

10 The object is achieved by the features of claim 1.

The homogeneous guidance of the flow of force ensures an optimum distribution of force in radial and tangential direction and hence an adequate rotatory and translatory joint deflection. Undesirable wear phenomena at the joint components are therefore reduced to a minimum.

In a delimitation from the background art, the homogeneous radially symmetrical flow of force in the joint is realized by the joint components: suspension part, sliding band and connecting part, which exercise the functions of the joint ball, the joint-ball bearing and the connecting flange of the background art. The sliding movement of an annular sliding band, which is fastened to the part-spherical internal diameter profile of the connecting part, on the part-spherical external diameter surface of the suspension part leads to an articulated tilting and rotational movement between suspension part and connecting part. By virtue of the use of an annular sliding band of a constant thickness and by virtue of the construction of part-spherical contact surfaces between suspension part, sliding band and connecting part, the forces at the articulated points are guided in a radially symmetrical and hence homogeneous manner.

Advantageous developments of the invention are indicated in the sub-claims.

5 The articulated movement of the connecting part relative to the suspension part leads to the formation of a slot aperture between both components that has a different slot aperture width depending on the respective joint angle. To avoid dust deposits in the slot aperture and to protect  
10 against injuries caused by the trapping of body parts in the slot aperture, the suspension device preferably has an enclosure that covers the slot aperture, on the one hand, in as space-saving a manner as possible and, on the other hand, as comprehensively as possible for all aperture  
15 widths.

To avoid damage to the wiring cable integrated in the suspension device, a restriction of the rotational movement of the connecting part relative to the suspension part to  
20 360° is preferably provided.

There now follows a detailed description of an embodiment of the invention with reference to the drawings. The drawings show:

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- Fig. 1: an axial section through an embodiment of the articulated suspension device according to the invention in the non-deflected state;
- 30 Fig. 2: the axial section of the articulated suspension device according to the invention in the deflected state;

Fig. 3a: a cross section through the enclosure and

Fig. 3b: a cross section, rotated through  $90^\circ$  relative to Fig. 3a, through the enclosure.

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The articulated suspension device according to the invention is explained below with reference to the drawings.

10 In Fig. 1 an embodiment of an articulated suspension device in the non-deflected state is illustrated in cross section. The articulated suspension device comprises the rotationally symmetrical suspension part 1. This rotationally symmetrical suspension part 1 comprises three  
15 different portions 1', 1'' and 1'''. The cylindrical portion 1', which is inserted by its full length in a hollow cylindrical spring arm 2, has a constant external diameter, which corresponds to the internal diameter of the hollow cylindrical spring arm 2. Outside the inner  
20 cylinder of the spring arm 2 the cylindrical portion 1' of the rotationally symmetrical suspension part 1 is adjoined by a further cylindrical portion 1'' with a constant external diameter, which is reduced compared to the portion 1'. The end of the rotationally symmetrical  
25 suspension part 1 is formed by a portion 1''' having an external diameter profile which, according to claim 1, has a part-spherical contour. In the illustrated embodiment, the external diameter of the portion 1''' increases from the constant external diameter of the cylindrical portion 1'' in  
30 accordance with a part-spherical profile to the equatorial diameter of a hemisphere corresponding to the part-spherical profile at the end of the portion 1''' that

corresponds to one end of the rotationally symmetrical suspension part 1.

Fastening of the rotationally symmetrical suspension part 1 in the portion 1' to the spring arm 2 is effected by means of a fit joint. For this purpose, an annular groove 3 is provided in the lateral cylinder surface of the cylindrical portion 1' of the rotationally symmetrical suspension part 1. At the same height as the annular groove 3 of the rotationally symmetrical suspension part 1, through-openings 4 are provided in the hollow cylindrical spring arm at identical angular distances along a peripheral line. A preferably U-shaped fit element 5, which is inserted half in the annular groove 3 and half in the through-bore 4, prevents a movement of the suspension part 2 in axial direction and in direction of rotation relative to the spring arm 2.

Besides the suspension part 1, the joint component combination comprises the connecting part 5. This connecting part 5 is subdivided into a hollow cylindrical portion 5' with a constant external and internal diameter profile and a hollow cylindrical portion 5'' with a part-spherical internal and external diameter contour. In the illustrated embodiment, the connecting part 5 has a constant wall thickness over all portions 5' and 5''. The internal diameter of the hollow cylindrical portion 5' in the illustrated embodiment is larger by a specific amount than the maximum external diameter of the suspension part 1. The internal diameter of the connecting part 5 decreases in the portion 5'' from the internal diameter of the portion 5' in accordance with the part-spherical external diameter contour of the suspension part 1 in the

portion 1" to the internal diameter D illustrated in Fig. 2, so that upon suspension of the connecting part 5 on the suspension part 1 in the non-deflected state the clearance between the suspension part 1 in the portion 1'" and the connecting part 5 in the portion 5" is constant over the entire part-spherical contour profile. The internal diameter D defines the maximum tilting angle of the connecting part 5 relative to the suspension part 1. Because of the constant wall thickness of the connecting part 5 over the entire lateral cylinder surface, the external diameter profile in the portion 5" presents the same part-spherical profile as the corresponding internal diameter contour and the external diameter contour of the suspension part 1 in the portion 1'".

For fastening the support system, in the illustrated embodiment a plurality of bores 6 are provided in the hollow cylindrical portion 5' of the connecting part 5 at identical angular distances along a peripheral line.

The third component of the joint component combination, which exercises the same function as the joint-ball bearing in the background art, is an annular sliding band 7. This annular sliding band is fastened to the inner lateral cylinder surface in the portion 5" of the connecting part 5. As it completely fills the sleeve-shaped, part-spherical gap between suspension part 1 in the portion 1'" and connecting part 5 in the portion 5", it is of a constant thickness and has an internal diameter profile corresponding to the part-spherical external diameter profile of the suspension part 1 as well as an external diameter profile corresponding to the part-spherical internal diameter profile of the connecting part 5.

The enclosure 9 needed to cover the slot aperture 8 situated between suspension part 1 and connecting part 5 comprises the hollow cylindrical portion 9' having a constant external and internal diameter and the hollow cylindrical portion 9'' having a part-spherical contour profile. In the illustrated embodiment, the enclosure 9 has a constant wall thickness, which is smaller than the depth of the step formed on the suspension part 1 at the transition from portion 1' to portion 1''. The constant internal diameter in the portion 9' corresponds to the constant external diameter of the suspension part 1 in the portion 1''. The internal diameter in the portion 9'' increases from the internal diameter in the portion 9' in accordance with the part-spherical external diameter contour of the connecting part 5 in the portion 5'' to the equatorial diameter of a hollow sphere corresponding to the part-spherical profile, so that, given a space-saving covering of the slot aperture 8 and of the portion 5'' of the connecting part 5 by the enclosure portion 9'' of the enclosure 9, the clearance between the connecting part 5 in the portion 5'' and the enclosure 9 in the portion 9'' is constant over the entire part-spherical contour profile.

25 The enclosure 9 in its portion 9' is fastened by a plurality of connections 10, which are distributed at identical angular distances along a peripheral line, in such a way to the portion 1'' of the suspension part 1 that the entire portion 1' is surrounded by the enclosure 9.

30 The connections 10 are realized by through-bores 10', which are distributed at identical angular distances along the peripheral line of the enclosure 9, and by bores 10'' disposed concentrically therewith in the suspension part 1

as well as by matching connecting pins (not shown in Figs. 1 and 2).

The rib 11 needed to restrict the rotational movement of the connecting part 5 relative to the suspension part 1 is fastened in axial direction along the internal profile of the enclosure 9 in the portion 9". For this purpose, the rib 11 at its underside has in axial direction the same part-spherical contour as the internal profile of the enclosure 9 in the portion 9". In order to guarantee the freedom of rotation between enclosure 9 and connecting part 5, the upper side of the rib 11 likewise has a corresponding part-spherical contour profile, wherein the constant height of the rib 11 between upper side and underside is designed to be smaller than the constant clearance between the external contour of the connecting part 5 and the internal profile of the enclosure 9. The rib 12 corresponding to the rib 11 is disposed likewise in axial direction along the external contour of the connecting part 5 in the portion 5". So that the freedom of rotation between enclosure 9 and connecting part 5 is not impeded by the rib 12 either, the rib 12 at its upper side also has a corresponding part-spherical contour profile. The constant height of the rib 12 is of a smaller dimension than the constant clearance between the external contour of the connecting part 5 and the internal contour of the enclosure 9.

The invention-specific mode of operation of the articulated suspension device arises from the sliding movement of the annular sliding band 7 with its part-spherically curved inner surface along the part-spherically curved outer surface of the suspension part 1 in the portion 1", which

movement gives rise to a corresponding tilting and/or rotational movement of the connecting part 5 relative to the suspension part 1. Because of the constant thickness of the annular sliding band 7 and the part-spherical

5 construction of all of the contact surfaces between suspension part 1, sliding band 7 and connecting part 5 a homogeneous, radially symmetrical flow of force inside the spherical joint is possible, thereby markedly reducing the wear of the joint parts.